# APPENDIX E

# GROUNDWATER RECHARGE AND REUSE,

# PHASE 1 – FAVORABLE ZONE IDENTIFICATION

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April 25, 2005

**Method of Transmittal**
Federal Express

New Hampshire Seacoast Project Team
c/o Matthew Formica
Metcalf & Eddy, Inc.
701 Edgewater Drive
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**RE: New Hampshire Seacoast Wastewater Management Study, Task 4.2.3 Groundwater Recharge and Reuse, Phase 1 – Favorable Zone Identification Task, ENSR Project Number 04632014**

Dear Team Members:

This letter summarizes the process and results of the Phase 1 - Favorable Zone Identification task presented in the proposed approach letter to the team from Jack Donohue, ENSR, dated March 8, 2005. If the team determines further study is warranted after the Phase 1 results are reviewed, the Phase 2 ranking analysis, as detailed in the March 8th letter and refined below, will be performed by ENSR. A CD containing the Phase 1 resultant Geographic Information System (GIS) polygon data, in ESRI-Shapefile format, is included for your review and use.

The purpose of this Phase 1 GIS analysis is to determine if any potentially favorable areas for wastewater recharge or reuse remain in the Study Area after a set of exclusionary criteria are applied. These exclusionary criteria are a set of identified GIS data layers that indicate whether or not a compatible land use and land type exists in a given point in the Study Area. The Study Area consists of the 46 seacoast New Hampshire towns listed as an attachment and presented on the Phase 1 Favorable Zone Maps.

All of the GIS data used for this analysis were provided to ENSR by Metcalf & Eddy, Inc. on January 12, 2005. The sources of these data are NH GRANIT and the New Hampshire Department of Environmental Services (NHDES).

The analysis comprised two primary steps. First, the creation of a base map, showing mapped "aquifer materials"; second, the application of a suite of exclusionary criteria to eliminate portions of the mapped aquifers from further consideration. A description of this process follows.

## BASE-MAP DATA

### Aquifer Boundaries

The base-map data layer was derived from the Aquifer Boundaries polygon data obtained from NH GRANIT. This data layer was automated by NH GRANIT from maps generated as part of a state-wide groundwater resource study performed under a cooperative agreement between United States Geological Survey (USGS) and the NHDES Water Resources Division. The

reports from this study identify the mapped aquifer boundaries as the contact between stratified drift and till or bedrock valley walls. Existing surficial geologic maps, soils maps, well logs and field mapping were used to determine the locations of these contacts.

The specific GIS data sets used for the base-map data layer consist of the Cocheco, Bellamy, and Salmon Falls Area (NH GRANIT Code: "cc"), the Lamprey, Exeter, and Oyster River Area (NH GRANIT Code: "la"), and the Lower Merrimack Area (NH GRANIT Code: "lm") aquifer boundaries data. These data sets were merged for use as the base-map data layer, from which the exclusionary criteria were removed.

### Surficial Materials

The New Hampshire Geological Survey (NHGS) has automated 14 USGS quadrangle-size maps of Surficial Materials within the Study Area for use with GIS. This covers approximately 50% of the study area (14 of the 29 quadrangles). The polygon features in the Surficial Materials data coded with surficial units representing sand or sand and gravel materials were selected for consideration in the Phase 1 Favorable Zone Identification Task. Due to the limited coverage across the Study Area, these data are displayed separately from the Aquifer Boundary data on the Phase 1 Favorable Zone Map 1. These data layers were only available for USGS Quadrangles (NH GRANIT quad ID): 126, 140, 154, 155, 156, 166, 167, 168, 169, 170, 184, 185, 186, and 202. See the attached list of study area quadrangle names and ID's.

The areas of sand or sand and gravel identified in the Surficial Materials data are primarily coincident with the areas delineated for the Aquifer Boundaries data. However, the identified sand and sand and gravel areas outside of the mapped aquifer areas are included in this phase of the study to ensure consideration is given to any areas with evidence of potentially well drained materials.

## Exclusionary Criteria

The base-map data layer was modified by applying the following exclusionary criteria. The areas generated from the exclusionary criteria were removed from the aquifer data layer. The resultant aquifer areas, provided in ESRI-shapefile format, are presented on the Phase 1 Favorable Zone Maps. The exclusion process assumes that if any one of these criteria is present in a given area, the area is not suitable for the recharge or reuse disposal option.

### Urban or Developed Areas

Urban or developed areas were identified using the New Hampshire Land Cover Assessment, 2001, with classifications based on Landsat Thematic Mapper(TM) imagery. Grid cells coded as 110 - Residential/Commercial/Industrial, were selected for this exclusionary criterion. This is the only code in the attribute table that applies to developed areas. It does not conclusively identify all developed areas, but provides a good initial estimate of areas with urban, industrial, and dense residential development.

### Wetlands

Wetland areas were derived from the hydrographic polygon data generated from USGS 1:24,000 Digital Line Graphs, automated by NH GRANIT, and the National Wetlands Inventory

(NWI) data, automated by US Fish and Wildlife Service. All of the delineated areas in the NWI data with an attribute code other than "U" ("upland") were considered wetland areas not favorable for groundwater recharge applications. The wetland areas identified by either of these sources were removed from the Aquifer Boundary base-map data.

**Roads (50 foot buffer)**

A 50-foot buffer along all of the line features of the "Roads" data layer was generated and subtracted from the aquifer base-map layer. The "Roads" GIS data were digitized by NH GRANIT from USGS Digital Line Graphs at a scale of 1:24,000.

**Drinking Water Reservoirs (1,000 foot buffer)**

Drinking water reservoirs were selected from the hydrographic polygon data by their NH GRANIT code for reservoir and by the water supply 'source-type' code in the water-user point data layer (watuse.shp) for surface water withdrawals.

**100-year Flood Plain (limited coverage)**

Digitized FEMA flood-plain data were available for 26 of the 46 towns located in the study area. Polygons coded as 100-year flood-plain areas were removed from the aquifer base-map data layer.

**Wellhead Protection Areas (a) All Public Supplies, b) Community Supplies Only)**

The GIS wellhead protection area (WHPA) polygon data used for this criterion were generated by the NHDES Drinking Water Source Protection Program, Water Supply Engineering Bureau. The data used for this task was created in October 2004.

There are 1,056 public water supplies located within the study area based on the GIS database records. Of these public water supplies, 494 are community supplies, 196 are non-community/non-transient supplies, and 366 are non-community/transient supplies. There are 306 WHPA's established for community water supplies, 105 WHPA's for non-community/non-transient water supplies and 8 WHPA's for non-community/transient supplies. The remaining 637 water supplies do not have established WHPA's delineated in the NHDES GIS database.

In order to identify the influence of protective setbacks from public water supply wells on the potentially favorable areas identified in this task, three wellhead protection criteria were applied. 500-foot setbacks from all public water supplies in the Study Area were applied to reflect the setback criteria identified for non-irrigation, groundwater recharge through ground-surface application, in the table "Wastewater Discharge Land Application Reuse and Recharge Effluent Permit Limits for Plant Evaluations", provided by Metcalf & Eddy, Inc. This setback was selected since it is the most conservative distance referenced for land application in this table. The WHPA's for the public water supplies were also applied as potential exclusionary criteria. One scenario eliminates the aquifer areas underlying the WHPA's for the community water supplies; the other scenario eliminates the aquifer areas underlying the WHPA's for all of the public water supplies (community and non-community). These scenarios are displayed on the accompanying maps.

## PHASE 1 FAVORABLE ZONE IDENTIFICATION RESULTS

The Phase 1 Favorable Zone Map 1 illustrates the aquifer areas remaining after the exclusionary criteria and the WHPA's for community public water supplies were removed. This area is displayed as the light red/salmon color. The map also displays the features that represent the exclusionary criteria. The resultant GIS file generated by this scenario is titled "aq-dvlp-flp-wtld-nwi-rsvr-rds-comwhpa.shp". The file is named to represent the aquifer boundary data (aq) minus the developed land (dvlp), flood plains (flp), wetlands (wtld), National Wetlands Inventory areas (nwi), reservoir buffers (rsvr), roads (rds), and the community wellhead protection areas (comwhpa). Where available, the sand and sand and gravel areas from the Surficial Materials data are displayed for reference. These areas fall primarily within the mapped aquifer areas, however the areas beyond the aquifer boundaries may be potentially favorable zones.

The Phase 1 Favorable Zone Map 2 illustrates the aquifer areas remaining after the exclusionary criteria are removed (light red/salmon color). The WHPA's for all of the community and non-community water supplies are displayed in a manner that allows for a visual evaluation of the underlying aquifer area. The resultant favorable-area GIS file generated by scenario is titled "aq-dvlp-flp-wtld-rsvr-rds.shp". The WHPA file, "SeacoastWHPA_Oct04.shp", is used to fade the aquifer areas excluded by all of the WHPA's. The Phase 1 Favorable Zone Map 2 also displays areas that are identified to be either cleared land, hay/pasture land, or row crops, based on the 2001 Landsat Imagery. These are areas can help target and rank favorable areas in the Phase 2 Zone Ranking Process as more detailed evaluations of the recharge and reuse option proceed.

Generally, the aquifer areas that may be suitable for groundwater recharge were considerably fragmented by the roads and development criteria. However, many potentially favorable areas are still present and may prove to be viable locations for wastewater reuse and groundwater recharge applications. For example, there are many unfragmented areas of sufficient size (e.g. greater than 20 acres) that were identified through this Phase 1 Favorable Zone Identification process. There are many factors that need to be considered to assess the potential of any of the remaining areas.

## PHASE 2 ZONE RANKING PROCESS

In order to prioritize the aquifer areas identified in Phase 1 in terms of their favorability for groundwater recharge, a number of additional factors might be assessed. Essentially a ranking of each of the potential areas can be developed to objectively determine the most promising areas by scoring these factors in a systematic manner.

The factors that might be evaluated for each of the areas identified in Phase 1, at a minimum, should include:

- Area of Unfragmented Land
- Current Land Use
- Transmissivity
- Unsaturated Thickness
- Proximity to Nearest Surface Water

- Proximity to Existing Water Supply (Public and Domestic)
- Land Protection Status
- Topography
- Distance from Wastewater Treatment Plant

Each of these criteria can be evaluated with available GIS data, though some limited ground-truthing would help to ensure accuracy with respect to the current land use, although budgetary constraints may preclude this.

The WHPA's applied in Phase 1 should be used as a factor in the ranking process. The large areas removed by the established WHPA's may be excessively restrictive at this point in the evaluation process. According to the Metcalf & Eddy table, "Wastewater Discharge Land Application Reuse and Recharge Effluent Permit Limits for Plant Evaluations", a 500-foot setback for groundwater recharge through ground-surface application may be all that is required. A thorough assessment of the flow paths to water supply wells from ground-surface application of wastewater would need to be performed at a later time in the evaluation process.

The Phase 2 Zone Ranking Process will result in a prioritized list of potential areas that will ultimately need a Preliminary Site Evaluation (Phase 3). Factors that will need to be assessed further include property parcel sizes, ownership, property availability, and sensitive receptors (endangered/threatened species, protected watersheds, Prime wetlands, etc...).

As a next step, we would like to review this process and the results with the project team and as appropriate, finalize the Phase 2 criteria and approach. Dave Mitchell will be in touch to make these arrangements. In the interim, please do not hesitate to call with any questions or comments.

Sincerely,

Albert N. Pratt
Water Resources Specialist

John J. Donohue IV
Vice President
Hydrogeology and Water Supply

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Enclosures: Phase 1 Favorable Zone Map 1
Phase 1 Favorable Zone Map 2
Attachments: Study Area Towns and USGS Quadrangle Names and ID Codes

cc: Dave Mitchell, ENSR

New Hampshire Seacoast Wastewater Management Study
GIS Data Provided by Metcalf Eddy, Inc.
Source: NH GRANIT

April 25, 2005

**STUDY AREA TOWNS**

| NAME | FIPS | Flood Data Available |
|---|---|---|
| Alton | 1005 | |
| Barrington | 17005 | X |
| Brentwood | 15015 | X |
| Brookfield | 3015 | X |
| Candia | 15020 | |
| Chester | 15025 | X |
| Danville | 15030 | |
| Deerfield | 15035 | |
| Derry | 15040 | X |
| Dover | 17010 | X |
| Durham | 17015 | X |
| East Kingston | 15045 | X |
| Epping | 15050 | |
| Exeter | 15055 | X |
| Farmington | 17020 | X |
| Fremont | 15060 | X |
| Greenland | 15065 | |
| Hampstead | 15070 | |
| Hampton | 15075 | |
| Hampton Falls | 15073 | |
| Kensington | 15085 | X |
| Kingston | 15090 | X |
| Lee | 17025 | |
| Madbury | 17030 | X |
| Middleton | 17035 | X |
| Milton | 17040 | X |
| New Castle | 15100 | |
| New Durham | 17045 | |
| Newfields | 15105 | |
| Newington | 15110 | X |
| Newmarket | 15115 | |
| North Hampton | 15125 | X |
| Northwood | 15130 | |
| Nottingham | 15135 | |
| Portsmouth | 15145 | X |
| Raymond | 15150 | X |
| Rochester | 17050 | X |
| Rollinsford | 17055 | X |
| Rye | 15155 | X |
| Sandown | 15165 | X |
| Seabrook | 15170 | |
| Somersworth | 17060 | X |
| South Hampton | 15175 | |
| Strafford | 17065 | |
| Stratham | 15180 | |
| Wakefield | 3090 | X |

## USGS Quadrangle Names and ID Codes

| NAME | NH Quad ID |
|---|---|
| ALTON | 126 |
| BARRINGTON | 154 |
| BAXTER LAKE | 140 |
| CANDIA | 166 |
| DERRY | 182 |
| DOVER EAST | 156 |
| DOVER WEST | 155 |
| EPPING | 168 |
| EXETER | 185 |
| FARMINGTON | 127 |
| GILMANTON IRON WORKS | 125 |
| GOSSVILLE | 152 |
| GREAT EAST LAKE | 115 |
| HAMPTON | 186 |
| KINGSTON | 184 |
| KITTERY | 171 |
| MILTON | 128 |
| MT PAWTUCKAWAY | 167 |
| NEWMARKET | 169 |
| NORTHWOOD | 153 |
| OSSIPEE | 101 |
| PARKER MOUNTAIN | 139 |
| PORTSMOUTH | 170 |
| ROCHESTER | 141 |
| SANBORNVILLE | 114 |
| SANDOWN | 183 |
| WEST ALTON | 112 |
| WEST NEWFIELD | 102 |
| WOLFEBORO | 113 |

## Legend

- Remaining Aquifer Area - Phase 1 Criteria, Community WHPA's Removed
- Study Area
- Wastewater Treatment Facility (WWTF)
- WWTF 4-Mile Buffer

### System Type

- Community Supply
- Non-Community/Non-Transient
- Non-Community/Transient
- Surface-Water Supply Intake
- 500-foot Public Water Supply Buffer (White Circle)
- WHPA - Community PWS (Translucent Overlay)
- Surface-Water Supply Intake
- Road Buffer (50 feet)
- Developed Area (Landsat, 2001, Code 110)
- Reservoir Buffer (1,000 feet)
- Wetland (National Wetlands Inventory (NWI))
- Flood Zones (FEMA 100-year, where available)
- Sand or Sand and Gravel (From NHGS Data - where available)
- Reservoir
- Wetland
- Tidal Feature
- River or Lake
- Stream
- Intermittent Stream
- Town Boundary

Map Information:
This map is one of two created to illustrate the findings of the Phase 1 Favorable Zone Identification task for the evaluation of the Groundwater Recharge and Reuse option in the Seacoast NH Wastewater Management Study. All of the data used for this map were obtained from either NH GRANIT or the New Hampshire Department of Environmental Services (NHDES). NHDES has retained Metcalf & Eddy, Inc. to lead this study.
The Phase 1 Favorable Zone Identification task was intended to objectively determine the general extent of potentially feasible areas for the application of treated municipal wastewater. The potentially favorable areas, displayed in the light red/salmon color, are areas of known sand or sand and gravel deposits, based on the Aquifer Boundary GIS data generated by the US Geological Survey and NHDES. These areas were derived by removing areas of known incompatible land use or land types from the Aquifer Boundaries GIS data. The incompatible land uses or land types were defined for this task as exclusionary criteria. These criteria consist of: Developed Areas, Wetlands, Roads, Flood Plains, and 1,000 foot setbacks from Drinking Water Reservoirs. Wellhead Protection Areas (WHPA) were considered potential exclusion areas. See the accompanying Phase 1 Summary Letter for details regarding the findings of this task.
This map is intended to be used only for reference purposes. The areas remaining after the application of the exclusionary criteria are only the preliminary findings of this study. Further evaluations will refine the favorable areas in order to prioritize the potentially suitable sites.

Study Area

0 2.5 5 7.5 10 Miles

0 22,500 45,000 67,500 90,000 Feet

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May 31, 2005

# PHASE 1 FAVORABLE ZONE MAP 1

Groundwater Recharge and Reuse Option

New Hampshire Seacoast Region
Wastewater Management Study

## Legend

- Remaining Aquifer Area - Phase 1 Criteria, All WHPA's Removed
- Study Area
- Wastewater Treatment Facility (WWTF)
- WWTF 4-Mile Buffer

### System Type

- Community Supply
- Non-Community/Non-Transient
- Non-Community/Transient
- Surface-Water Supply Intake
- 500-foot Public Water Supply Buffer (White Circle)
- WHPA - All PWS (Translucent Overlay)
- Cleared Land (Landsat 2001 Data)
- Hay / Pasture (Landsat 2001 Data)
- Reservoir
- Wetland
- Tidal Feature
- River or Lake
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Study Area

0 3 6 9 12 Miles

0 23,000 46,000 69,000 92,000 Feet

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# PHASE 1 FAVORABLE ZONE MAP 2

Groundwater Recharge and Reuse Option

New Hampshire Seacoast Region
Wastewater Management Study